5-11-2018

The Importance of Interdisciplinarity: Redefining the Health Belief Model

Ross F. Lordo
University of South Carolina, rlordo@email.sc.edu

THE IMPORTANCE OF INTERDISCIPLINARITY: REDEFINING THE HEALTH BELIEF MODEL

By

Ross F. Lordo

Submitted in Partial Fulfillment
of the Requirements for
Graduation with Honors from the
South Carolina Honors College

May, 2018

Approved:

Darin Freeburg, Ph.D.
Director of Thesis

Kara Montgomery, M.Ed., Dr.P.H.
Second Reader

Steve Lynn, Dean
For South Carolina Honors College

Table of Contents

Acknowledgements……3

Thesis Summary……4

Abstract……5

Introduction……6

Introduction to Interdisciplinary Theory……..…..9

Health Belief Model……12

Game Theory……...15

Systems Theory……..17

Methods……...…19

Results……..……..24

Citation Distribution.……..24

Analysis of Interdisciplinary Components of Theories…….…..29

Guidelines for Interdisciplinary Theory Development…….….35

Discussion…….……...38

The Health Belief Model – A New Context...…….……...38

The Health Belief Model – Redefined…….……..…….42

Conclusion……...…….……...46

References…….…..……..48

ACKNOWLEDGEMENTS

I would like to thank some of the special people that have made this journey possible and so rewarding. To my mother and father – thank you for raising me to believe in the power of hard work, passion, and dedication. You have always pushed me to pursue these crazy dreams of mine and for that I will always be grateful. To Dr. Freeburg – thank you for taking this public health student under your wing three years ago and challenging my ideas from the start. I will always appreciate the time you put in as my thesis director and your support in guiding me along this journey that sometimes seemed never ending. To Dr. Montgomery – you will never understand how much you have been a role model and mentor to me throughout these four years. Your support has made such an impact on not only my life, but so many others. To Dr. Alexander – thank you for teaching me that research comes in all shapes and sizes and for always being there to help me when I needed you most. To Emily – thank you for being by my side and supporting me throughout this process, for understanding more than anyone when 'work days' were needed, and for challenging me to always be a better person.

THESIS SUMMARY

This thesis serves as an analysis of the importance of interdisciplinarity in our research and academic communities. Further, it is centered on understanding the role theories play in promoting such interdisciplinarity. Many theories are isolated in usage due to how they are described, whereas others are applicable in different fields.

With a background in public health, the health belief model is noted as an example of a theory that is primarily used to describe situations relating to health behavior. It is proposed that this model can be broadened and transformed to assist in understanding behavior in general. In contrast, game theory and systems theory are found to be theories that are published in a variety of disciplines. By analyzing the characteristics in how these respective theories are described and constructed, guidelines are created outlining how scholars can develop interdisciplinary theories that can be utilized to understand many situations.

Using these guidelines, a new version of the health belief model is proposed to make it more interdisciplinary. This redefining then helps understand how a transformed model can even assist in explaining why people do or do not volunteer in churches. If researchers work together, share information and knowledge, and promote a collaborative approach, interdisciplinarity can contribute to helping us understand the complex and interconnected world that exists around us, including why people behave the way that they may do.

ABSTRACT

Throughout academia, there lacks an existence of a commonly utilized multicomponent and interdisciplinary approach in understanding our outside world. This thesis provides an analysis of the current state of interdisciplinarity and the need to develop interdisciplinary theory. Through this effort, the researcher utilizes the health belief model as a framework that is severely limited in applicable scope due to its constructs. Contrastingly, systems theory and game theory are validated as examples of theories with an interdisciplinary nature. Through the coding of the literature pertaining to the qualitative characteristics of the health belief model, game theory and systems theory, guidelines in developing interdisciplinary theory are proposed to challenge scholars in theory construct descriptors and usage. Further, the guidelines provided are applied to redefine the health belief model to offer perspective in how it can describe relationships outside of health. Through an interdisciplinary approach in theory development, scholars can begin to demonstrate the power and impact of knowledge sharing in solving some of society's greatest challenges.

INTRODUCTION

In a world of increasing complexity, the importance of diversity in thoughts, opinions, and ideas is central to a well-functioning society. Over the past decade, the concept of interdisciplinarity has regained credibility, signaling the reinvention of novel approaches to issues that cannot simply be undertaken within the confined traditions of the disciplines (Ross, 2009). Defined by Engerer, interdisciplinarity serves as a relationship in which ideas and concepts from one discipline are introduced into the basic ideas and models of the other (2017). The movement of ideas between individuals or groups, termed knowledge flows, are key components to the cohesion and connectivity of academic research communities that are utilized to solve such problems (Rawlings, McFarland, Dahlander, & Wang, 2015). This movement allows for innovation that can lead to the successful implementation of creative ideas, tasks, and procedures (Amabile, 1988).

Previously, the ability for interdisciplinary collaboration to take place has been strained by physical distances between researchers and scientists (Allen, 1977). With added resources and energy needed to create this type of work, researchers were primarily confined to small circles of knowledge. If science continues to evolve into infinite sub-groups, the total growth of knowledge will be slowed by the loss of collective communication (Boulding, 1956). Utilizing integrated technology to exchange news, data, reports, equipment, instruments and other resources, dispersed collaborations are easier now than ever before (Hesse, Sproull, Kiesler, & Walsh, 1993). Such collaborations are fundamental in determining the importance of interdisciplinarity. It was noted throughout this analysis that a significant number of articles that called for a

renewed focus on interdisciplinarity were written by just one author. With modern technology paving the way for new processes in daily life, so should academia follow suit in the methods of research collaboration.

Throughout literature today, there lacks an existence of a commonly utilized multicomponent and interdisciplinary approach in a variety of areas. Simply put, different scientific disciplines use different methodologies for many of the same aspects of reality (Malecic, 2017). In the past, science has tried to explain observable phenomena by reducing them to elementary units that are investigable independently of one another (Bertalanffy, 1969). Such a practice lacks efficiency in explaining the world at large. For instance, as Cochrane et al. (2017) embarked on obesity management research, it was found that no interdisciplinary framework was effective in approaching obesity management and therefore, the researchers undertook and considered this approach to be exploratory in their study. Leridon (2015) examined the various theoretical approaches spanning distinct disciplines that have contributed to the development of fertility theories, proving that ideas have the potential to be both applicable and effective when utilized across intellectual boundaries. Research teams are slowly beginning to see the benefits of interdisciplinarity and using knowledge from other arenas, as it is common knowledge that policy-makers and funding entities look more favorable on scientific work across and between traditional disciplines, rather than simply within (Geschwind & Melin, 2016). There has even been the creation of important fields that have developed out of interdisciplinary collaborations (Cummings & Kiesler, 2005). Interdisciplinarity is known to have the potential to create a momentous impact, but it is the method by which this practice is followed that needs to be further defined.

When discussing interdisciplinarity, it is of equal importance to discuss the concept of reductionism, defined by Rorty (1963) as a "language which will require no additions to, or subtractions from, its list of undefined predicates in order to handle any such result." This concept can be considered similar to the notion of interdisciplinarity, however the researcher does not contend that it has an exclusive relationship. Further, with reductionism referring to the ability to describe a field with tools from another (Greene & Loscalzo, 2017), interdisciplinarity can align or misalign with this concept. The researcher proposes that reductionism can be used to explain the relationship between specific common ideas between disciplines, but that there does not exist a requirement that all phenomena in a discipline be described by reductionism. To clarify, a theory specifying a phenomenon in one discipline is recommended to strive to align with a higher-level theory, but it is possible there exists no higher-level conjoining concept. Only by experimentation and further research can this question be answered with complete confidence.

The long-term trends of academic institutions have been to continue to promote greater specialization, departmentalization, and fragmentation, yet macromodels of knowledge dispute the validity of this practice (Klein, 1996). A common belief is that certain disciplines are more permeable than others, reinforced by authors using value-laden terminology. This creates the perception of certain disciplines, specifically the sciences, as hard, tight, restrictive, and homogeneous (Klein, 1996). Contrastingly, it has been found that the hard sciences are a few of the most interdisciplinary fields in quantified networks (Silva, Rodrigues, Oliveira, & da F. Costa, 2013). From a broad perspective, the complexity of conflicts that have evolved throughout our society create

an unmet need for further interdisciplinary study, understanding, and theory (Klein, 1996), and the view of disciplines must accompany it. In a new age of research, there must be clearer guidelines surrounding the applicability of certain concepts across the boundaries of disciplines. Embracing such a concept in theory development can evolve society and academia in a way never previously observed.

As academia and research shifts towards a collaborative approach, the theories housed in singular arenas must follow in progression, laying the foundation for interdisciplinary theory to revolutionize the knowledge sharing network in solving some of the world's greatest problems. As early as the mid-twentieth century, physics, chemistry, biology, economics, sociology and others, have been called to go beyond developing theories that have a single application in their own empirical segment (Boulding, 1956). Such insulation is still proposed to exist due to groups of researchers from different disciplines working collectively but continuing to do so using theories from their own discipline (Rogers, Rizzo, & Scaife, 2003). Further, Olds (2006) notes that interdisciplinary information has already begun to change our unconscious, informal minds since Boulding's statement, but it has not yet advanced to the point of modifying formal theories. The question must be, however, what is the exact nature and importance of interdisciplinary theory in sparking collaboration and knowing across academic barriers?

INTRODUCTION TO INTERDISCIPLINARY THEORY:

To understand the nature and importance of interdisciplinary theory, the role of theory itself must be known. Theories have been described as generalizations that seek to explain the relationship certain phenomena have with others (Glazier & Grover, 2002).

They are meant to provide a comprehensive conceptual understanding for researchers to analyze complex problems and social issues (Reeves, Albert, Kuper, & Hodges, 2008). Further, a "theory" is known to be a multiple-level component of the research process, comprised of generalizations that move beyond descriptive keywords to a more explanatory level (Glazier & Grover, 2002). Glaser & Strauss (1967) add that distinct theories have certain qualities that make them valid and verifiable and are readily understandable to scientists, students, and laymen alike. In explaining phenomena, a theory should provide clear categories and hypotheses so that any conclusions are continually able to be verified in present and future research. A theory must be able to fit the situation being researched, meaning the categories are readily applicable and are relevant to the behavior under study (Glaser & Strauss, 1967), aiding into the debate about how generalized a theory can become to promote an interdisciplinary approach in answering questions.

Determining the appropriate level of generality of a theory has not been extensively defined throughout the literature. Such generality is the key to opening a theory to its usage in other disciplines, as Glazier and Grover (2002) propose that the construction of a framework in incorporating outside context "leads to an approach to theory building and research that more accurately mirrors the role of disciplines, the influence of social factors on the construction of personal and social knowledge, and the research process." Glazier and Grover (2002) introduced a concept termed circuits of theory that referred to evidence in the intertwined nature of research, theory, paradigms, and phenomena, stating the need for a more intrinsic multidisciplinary framework when developing a defined level of theory. There appears to be a reasonably wide

acknowledgement among researchers that varying amounts of generality are possible amongst theories, defined by Reeves et al. (2008) as grand theory, mid-range theory and micro level theory. Grand is defined as universal, societal level theories; mid-range theories focus on local systems; and micro level theories function to explain individual level actions. Reeves et al. (2008) consider grand theories to be non-specific and generated from abstract concepts but propose that any theory has potential to help people understand the wider significance and applicability of phenomena. Boulding (1956) states that with increased generality, content is sacrificed, an area that the researcher challenges due to Boulding's lack of evidence. This thesis argues that theory may contain various levels of explanatory description that can keep content applicable and valid for any situation it may describe.

At what point do researchers self-limit the proposed theory and harness it into a specific discipline? Theories, such as the health belief model (HBM), could be applicable outside of a singular area, yet are significantly limited in scope due to their parameters. In general, boundaries to theories are determined more by method and conceptual framework than necessarily by subject matter (Klein, 1996). Further, it has been noted that a method with both quantitative and qualitative analyses can help produce knowledge in understanding our society and social life (Feilzer, M. Y., 2010). For interdisciplinary theory to exist, theory development must take on an evolved approach to increase the level of applicableness that such a theory contains. If successful, the nature of interdisciplinary theory in having broader validity may completely alter the stringent confines of academic networks by drawing connections and similarities amongst disciplines.

In attempting to develop methodology in promoting theory development that spans discipline-specific arenas, examples of both isolated and broadly used models are imperative for comparison. In this analysis, the health belief model is examined as an example of a self-limiting theory that is published primarily in public health, whereas systems theory and game theory are recorded as having an increased diversification of citations, although it is noted that the researcher has no claims of expertise in these theories explicitly. Introducing and utilizing these theories as illustrations of differences in theory constructs lead to the ability to find key components of an interdisciplinary approach.

HEALTH BELIEF MODEL:

The health belief model attempts to explain the relationship between beliefs, attitudes and behaviors. Ajzen's and Fishbein's theory of reasoned action argues that beliefs lay the foundation for attitudes, which create intended behavior (Koch, Zhu, Cannon, Armstrong, & Owen, 2005). Within public health, several theories of health education, including the health belief model and the theory of reasoned action, are based around the idea of a rational individual decision maker (Balbach, Smith, & Malone, 2006). Throughout historical attempts to clarify, forecast, and influence health-related behavior, no theory has generated more research than the health belief model (Rosenstock, Strecher, & Becker, 1988). The health belief model (HBM) was originally termed by Rosenstock (1974a) as an idea resulting from "stimulus response" theory and "cognitive theory" which combines the concepts of classical conditioning and instrumental conditioning to attempt to describe behavior under conditions of uncertainty. At its origin, the HBM utilizes psychological theories of choice decision making to

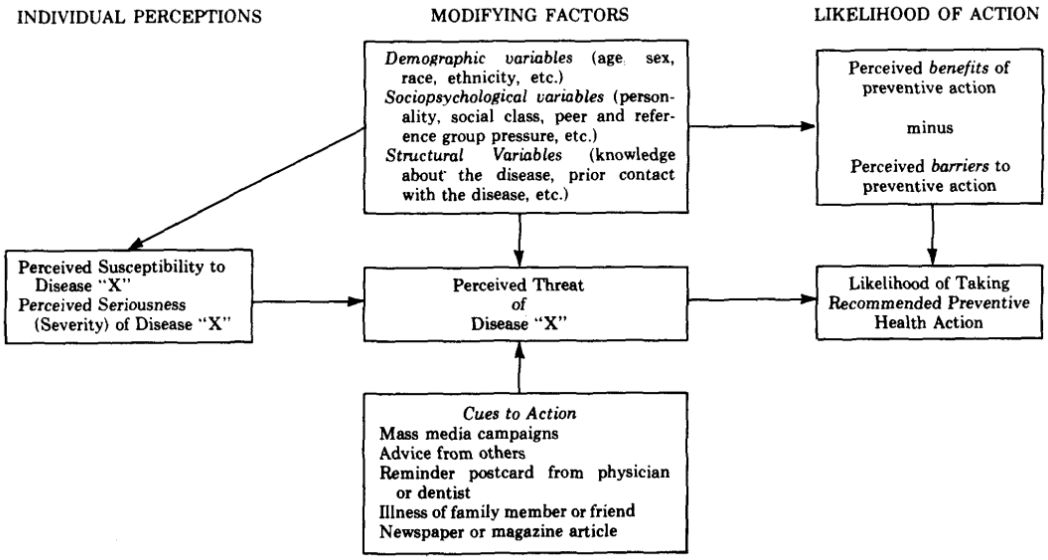
explain an individual's decision about alternative behaviors (Maiman & Becker, 1974), but also recognizes decisions must also account for noncognitive effects on attitude formation (Fishbein & Middlestadt, 1995). Often times associated with Bandura's social learning theory based on expectancies and incentives (Rosenstock et al., 1988), the HBM was developed in the 1950's to attempt to explain reasons why health behaviors were not changing in response to the medical advances of the time (Kirn, 1991). Like the closely related theory of reasoned action and theory of planned behavior that suggest that behavior and normative beliefs lead to intention to engage in a particular behavior (Balbach et al., 2006), the HBM constitutes a value-expectancy theory model (Taylor et al., 2006) leading to a great number of similarities between various frameworks. The models are similar in that a behavior is believed to be contingent on the value placed by an individual on a certain goal and the estimate that individual has for the action to achieve that goal (Maiman & Becker, 1974).

After over twenty-nine studies testing its effectiveness, results indicate strong empirical evidence for the HBM (Janz & Becker, 1984), laying the foundation for future research regarding its efficacy outside of health. Historically, the HBM has not been only centered on health-related behaviors (Salari & Filus, 2016), but studies have found that potential variations of the HBM on general behavior are consistent with applications of the theory to health-related actions (Lindsay & Strathman, 1997). Yoon & Kim (2016) used it to help understand the significant influences that shape global green advertising outcome. Lindsay & Strathman (1997) used it to aid in the prediction of recycling behaviors. It has even been applied to explain the decision-making process by which young adults express interest in getting a tattoo (Koch et al., 2005). These studies

showcase the ability for the HBM to have significant applicability and usage outside of just health.

The HBM (Rosenstock, 1974a) was constructed to understand what encouraged or discouraged people from participating in health prevention and detection programs (Lindsay & Strathman, 1997). The health belief model is centered on four distinct factors that are known to impact health-related behaviors and could be the key in opening its usage outside of health: perceived susceptibility, perceived seriousness, perceived benefit, and perceived barriers to entry.

Figure 1: The "Health Belief Model" as presented by Rosenstock (1974)



Perceived susceptibility refers to the subjective risks an individual has in contracting a condition. Individuals vary widely in their feelings of vulnerability (Janz & Becker, 1984). There are modifying factors present that can influence these perceptions, such as race, ethnicity, age, and marital and social-economic status, varying the susceptibility or benefit levels of each individual. Perceived seriousness has two aspects,

one that revolves around the emotional arousal created by the thought of the disease and the other by the believed difficulties the individual believes a condition could generate. This dimension includes the evaluation one has on clinical consequences and social consequences (Janz & Becker, 1984). The perceived benefits are the positive potential results one sees from a certain health behavior, such as threat reduction or effectiveness of action. This perception is greatly influenced by social norms and pressure. In contrast, perceived barriers include the negative aspects of a health action that are seen as being inconvenient or unpleasant. Based on the HBM, before a behavior is performed, it is proposed that the perceived benefits must outweigh the perceived barriers. Rosenstock (1974a) states, "The combined levels of susceptibility and severity provided the energy or force to act and the perception of benefits (less barriers) provided a preferred path of action."

GAME THEORY:

Game theory has been utilized by numerous researchers for its ability to promote collaborative multidisciplinary decision making (Xiao, Zeng, Allen, Rosen, & Mistree, 2005). It is concerned with the behavior of "rational" players using the appropriate strategies against a player or nature to obtain maximal gains and minimal losses (Bertalanffy, 1969).

The theory of games asserts that any finite game has a minimum of one equilibrium as an intersection of pure or mixed strategies among its outcomes, thereby guaranteeing the existence of equilibria that allows the possibility of choosing "rationally" (Rapoport, 1992). Game theory can be divided into noncooperative and cooperative branches (Saad, Han, Debbah, Hjorungnes, & Basar, 2009). Noncooperative

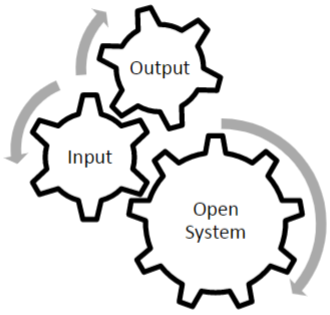
game theory explains the strategic choices that are a result of the interactions among independent, competing players fighting to improve their individual utility. Cooperative game theory focuses on the analytic tools to study rational player behavior when working amongst a team (Saad et al., 2009). The models of game theory create abstract representations of real-life situations, allowing them to be utilized in the study of a wide range of phenomena (Osborne & Rubinstein, 1994). For example, the theory of Nash equilibrium, a subdivision of game theory, has been studied in relation to oligopolistic and political competition. The theory of mixed strategy equilibrium has been referenced to explain the distribution of tongue length in bees and tube length in flowers. The theory of repeated games has illuminated social phenomena like threats and promises (Osborne & Rubinstein, 1994). These diverse sub-models that comprise game theory allow the theory's applicability in a wide array of academic disciplines.

The relevance of game theory is not simply its use across a variety of disciplines, as it was originally devised to simply study poker, chess, and other games, but has been later adapted to explain markets, competition, and even animal behavior (Pool, 1995). It is well known to be an important tool in numerous fields, including social sciences, biology, engineering, political science, international relations, and others, to assist in understanding both cooperation and conflict between individuals (Wang, Wu, & Liu, 2010). Game theory shows that the original construction of the theory does not have to stand as its only avenue of applicability, rather its influence can span across defined disciplines.

SYSTEMS THEORY:

In the beginning of the twentieth century, Ludwig von Bertalanffy introduced the concept of the general systems theory (Miranda, 2014) not as a rigid doctrine, but in the development of its ideas which can serve as a foundation for future study and investigation (Bertalanffy, 1969). Systems theory is an interdisciplinary theory that almost every system in scientific domains pertains to as it serves as a framework from which we can investigate phenomena from a holistic approach (Mele, Pels, & Polese, 2010).

Figure 2: Schematic of relationship between input and output of an open system from Miranda (2014)



Systems theory states that a living organization or system represents many elements that are arranged in a specific hierarchical order in which a variety of complex processes, in exchange with the environment, develop and maintain its integrity (Miranda, 2014). Bertalanffy (1969) emphasized that real systems interact with their environments and subsequently, can acquire new properties through emergence.

Systems theory was created in response to mathematics' attempt to establish relationships into a system without a connection with the "real" world that surrounds us

(Boulding, 1956). It does not seek to establish a single general theory of everything, rather offers an alternative to special theories of particular disciplines. The tendency in contemporary science can no longer focus on isolating phenomena in narrowly confined contexts, rather it must be open to interactions with larger and larger slices of nature (Bertalanffy, 1969). From a broad perspective, the theory aims to point out similarities in the theoretical constructions of different disciplines, and to develop theoretical models having applicability to at least two different fields of study. One of the major functions of systems theory research was noted by Bertalanffy (1969), "to further the development of theoretical systems which are applicable to more than one of the traditional departments of knowledge."

The creation of systems theory seeks out principles, models, and laws that can apply to systems in general, irrespective of whether they are sociological, biological, or physical in nature. It offers itself as a general science of wholeness that had previously not existed. The general systems theory had five aims (Bertalanffy, 1969): (1) There is a general tendency towards integration in the various sciences, natural and social. (2) Such integration seems to be centered in a general theory of systems. (3) Such theory may be an important means for aiming at exact theory in the nonphysical fields of science. (4) Developing unifying principles running vertically through the universe of the individual sciences, this theory brings us nearer to the goal of the unity of science. (5) This can lead to a much-needed integration in scientific education. The pursuit systems theory undertakes to be a comprehensive explanation of our world aligns its categorization as a proposed interdisciplinary theory.

METHODS

The following paper is structured to provide perspective to the importance of interdisciplinarity in theory development. Through this effort, the researcher utilizes the heath belief model as a framework that is proposed to be severely limited in applicable scope due to its health-specific constructs. Contrastingly, systems theory and game theory are referenced as proposed examples of theories with an interdisciplinary nature.

To study the hypothesis that the health belief model (HBM) is primarily isolated in its applicability to public health, a citation analysis was conducted to quantify the model's respective publishing in specific academic areas. In coming closest to the most authentic multidisciplinary database that provides the earliest origin of data, in comparison to *Scopus* and *Google Scholar* (Jacso, 2005), the *Web of Science* was the chosen database reference tool of choice for the thesis. Searching the *Web of Science Core Collection* on November 29th, 2017, the field was populated with "<THEORY NAME>" as the topic and limited to only peer-reviewed journal articles. Using the Web of Science's "analyze results" feature, article classification data was gathered in sorting by "research areas" to quantify the frequency of theory publication in specific disciplines. If an article was deemed to be interdisciplinary itself, each field comprising the study would be included in the calculation.

A chi-squared analysis with 95% confidence was performed between the resulting highest two research areas within which each respective theory was published to determine if at least one area was statistically significant and isolated in distribution. The two primary areas for each theory that underwent a chi-squared analysis are explicitly outlined and the remaining eight highest are listed for reference in the results.

From a quantitative perspective, analyzing the areas of publication of these theories and confirming the interdisciplinary nature of systems theory and game theory provided validation for further study. What are the elements of systems and game theory that make them more interdisciplinary, compared to the health belief model? To confront this question, a coding mechanism was utilized in the analysis of these theories to discover qualitative characteristics that may be applicable to developing and defining theory constructs.

To code the most influential literature for each respective theory within *Web of Science*, the ten most cited peer-reviewed articles that incorporated the theory name in the title were chosen. Such methodology was followed to permit a uniform coding process of selection for all three theories. It is significant that the ten articles did not always contain extensive descriptions of the theories' constructs. The methodology was believed to be effective in offering examples of the most-referenced studies that use each theory that potentially expose scholars to their respective ideas.

The researcher notes that when sorting for the ten most-cited articles for "systems theory" within *Web of Science*, certain results were omitted due to their irrelevance. Within the database, the capability does not exist to separate "systems theory" from "systems: theory" or "systems- theory." As a result, there were articles that populated that were considered false positives in not pertaining to general systems theory, such as "Interval type-2 fuzzy logic systems: theory and design." The top ten most-cited articles pertaining to general systems theory were coded for interdisciplinary trends and qualities.

The ten articles coded for each theory are listed below. To understand interdisciplinary characteristics holistically, systems theory and game theory were coded

collectively. Qualitative procedures based in grounded theory create an applicable avenue for drawing conclusions (Corbin & Strauss, 1990). To pinpoint specific characteristics that differentiate systems and game theory as more interdisciplinary than the HBM, the theories were coded to analyze specific characteristics that may distinguish them following guidelines in grounded theory research listed by Corbin and Strauss (1990). The coding method is further detailed.

Table 1: Literature coded for analysis

Literature for Analysis

Health Belief Model	Systems Theory	Game Theory
The health belief model – A decade later (Janz & Becker, 1984)	*General systems theory – The skeleton of science* (Boulding, 1956)	*Incorporating fairness into game theory and economics* (Rabin, 1993)
Social-learning theory and the health belief model (Rosenstock et al., 1988)	*Toward a general modular systems theory and its application to interfirm product modularity* (Schilling, 2000)	*The ecology of fear: Optimal foraging, game theory, and trophic interactions* (Brown, Laundré, & Gurung, 1999)
Historical origins of health belief model (Rosenstock, 1974a)	*A dynamic systems theory approach to second language acquisition* (Bot, Lowie, & Verspoor, 2007)	*The evolution of the labor market for medical interns and residents: A case study in game theory* (Roth, 1984)
Health belief model and preventive health behavior (Rosenstock, 1974b)	*Toward a systems theory of motivated behavior in work teams* (G. Chen & Kanfer, 2006)	*Coalitional game theory for communication networks* (Saad et al., 2009)
Health belief model and prediction of dietary compliance – Field experiment (Becker, Maiman, Kirscht, Haefner, & Drachman, 1977)	*Complexity theory, systems theory, and multiple intersecting social inequalities* (Walby, 2007)	*The economist as engineer: Game theory, experimentation, and computation as tools for design economics* (Roth, 2002)
A metaanalysis of studies of the health belief model with adults (Harrison, Mullen, & Green, 1992)	*A systems theory approach to the feedback stabilization of infinitesimal and finite-amplitude disturbances in plane Poiseuille flow* (Joshi, Speyer, & Kim, 1997)	*Game theory and physics* (Hauert & Szabó, 2005)
Health belief model and sick role behavior (Becker, 1974)	*Data quality and systems theory* (Orr, 1998)	*Game theory for cognitive radio networks: An overview* (Wang et al., 2010)
Breast and cervical cancer screening in Hispanic women: A literature review using the health belief model (Austin, Ahmad, McNally, & Stewart, 2002)	*General systems theory – Applications for organization and management* (Kast & Rosenzweig, 1972)	*Using game theory to analyze wireless ad hoc networks* (Srivastava et al., 2005)
A meta-analysis of the effectiveness of health belief model variables in predicting behavior (Carpenter, 2010)	*Unruly categories: A critique of Nancy Fraser's dual systems theory* (Young, 1997)	*Marxism, functionalism, and game-theory – The case for methodological individualism* (Elster, 1982)
Health belief model – Origins and correlates in psychological theory (Maiman & Becker, 1974)	*The structure and significance of strategic episodes: Social systems theory and the routine practices of strategic change* (Hendry & Seidl, 2003)	*Transaction analysis in deregulated power systems using game theory* (Ferrero, Shahidehpour, & Ramesh, 1997)

The following grounded theory approach is utilized as a method to define qualitive research in the social sciences (Corbin & Strauss, 1990). In identifying common words or phrases present within the data, or in this case, published literature, a researcher gives such phenomena conceptual labels detailing the specific language utilized. Similar concepts and phrases that describe comparable phenomena were then grouped to from categories, such as “generalized verbiage.” Corbin & Strauss (1990) refer to these categories as being “higher in level and more abstract than the concepts they represent.” A visual representation is provided below.

Figure 3: Grounded theory approach based on Corbin & Strauss (1990)

Using the coding results, guidelines in developing interdisciplinary theory were proposed. These guidelines require further study but offer a starting point in expanding previously isolated theories of the past. The proposed guidelines were then applied to reframe the statistically isolated and self-limiting health belief model to increase its interdisciplinary potential. Referring to the few studies that have successfully utilized the health belief model outside of the public health sector, the reframing is used here to describe the lack of volunteering in local church communities.

RESULTS

The results include both quantitative and qualitive data as recommended by Feilzer (2010). The quantitative citation distribution data is listed first followed by the qualitative coding results to determine the proposed interdisciplinary characteristics of theory. These results where then applied to propose the guidelines for interdisciplinary theory development.

CITATION DISTRIBUTION:

The quantitative results of each theory's citation distribution are outlined by the top ten research areas of publication specified in the table. The chi-squared analysis data is also listed. Each theory has data on its own respective page.

HEALTH BELIEF MODEL:

Citation Distribution

Research Area	*Record Count*	*%*
PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH	807	34.62%
* *PSYCHOLOGY*	387	16.60%
NURSING	256	10.98%
ONCOLOGY	181	7.77%
HEALTH CARE SCIENCES SERVICES	170	7.29%
GENERAL INTERNAL MEDICINE	166	7.12%
EDUCATION EDUCATIONAL RESEARCH	142	6.09%
SOCIAL SCIENCES OTHER TOPICS	90	3.86%
BIOMEDICAL SOCIAL SCIENCES	88	3.78%
PSYCHIATRY	71	3.05%
Total	*2358*	

* = Significance in distribution variation (.95)

Chi-Square Analysis

Research Area	*Actual Value*	*Expected Value*	*(Actual-Expected)^2 Expected*
PUBLIC HEALTH	807	597	73.869347
PSYCHOLOGY	387	597	73.869347
Chi-Square Value	147.738693		
P-value	< 0.00001	**Significant**	

GAME THEORY:

Citation Distribution

Research Area	Record Count	%
ENGINEERING	5888	29.86%
COMPUTER SCIENCE	5771	29.26%
BUSINESS ECONOMICS	4277	21.69%
TELECOMMUNICATIONS	2529	12.82%
OPERATIONS RESEARCH MANAGEMENT SCIENCE	2485	12.60%
MATHEMATICS	1956	9.92%
AUTOMATION CONTROL SYSTEMS	1027	5.21%
ENVIRONMENTAL SCIENCES ECOLOGY	911	4.62%
PHYSICS	630	3.20%
MATHEMATICAL METHODS IN SOCIAL SCIENCES	586	2.97%
Total	*26060*	

Chi-Square Analysis

Research Area	*Actual Value*	*Expected Value*	*(Actual-Expected)^2 Expected*
ENGINEERING	5888	5829.5	0.5870572
COMPUTER SC.	5771	5829.5	0.5870572
Chi-Square Value	1.174114418		
P-value	0.27856	**Not Significant**	

Citation Distribution

Research Area	Record Count	%
COMPUTER SCIENCE	1596	16.72%
ENGINEERING	1560	16.34%
PSYCHOLOGY	1206	12.63%
PHYSICS	1145	11.99%
BUSINESS ECONOMICS	835	8.75%
MECHANICS	803	8.41%
MATHEMATICS	777	8.14%
AUTOMATION CONTROL SYSTEMS	754	7.90%
SOCIAL SCIENCES OTHER TOPICS	479	5.02%
EDUCATION EDUCATIONAL RESEARCH	316	3.31%
Total	*9471*	

Chi-Square Analysis

Research Area	*Actual Value*	*Expected Value*	*(Actual-Expected)^2 Expected*
COMPUTER SC.	1596	1578	0.2053232
ENGINEERING	1560	1578	0.2053232
Chi-Square Value	0.410646388		
P-value	0.521462	**Not Significant**	

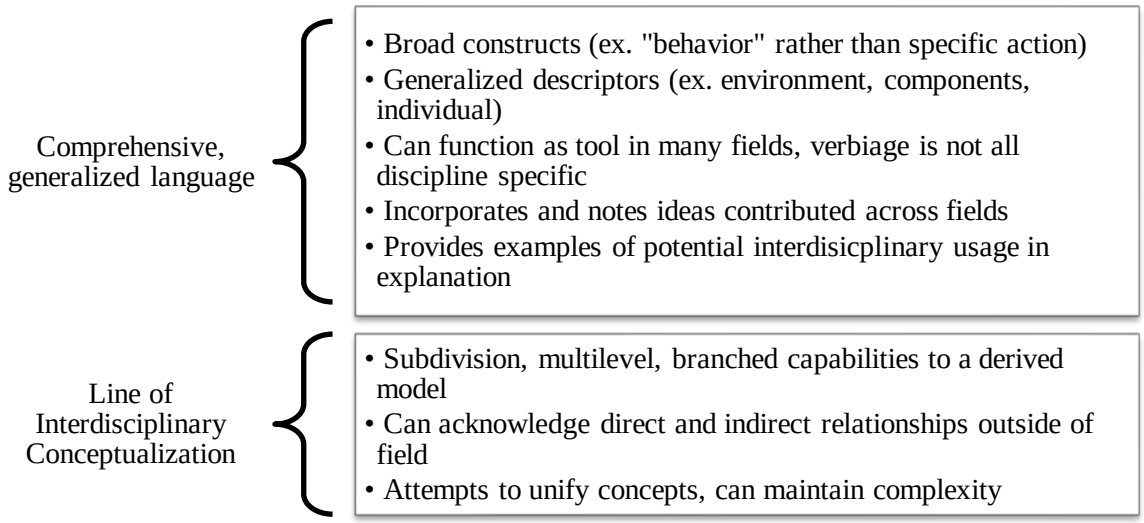
While the researcher acknowledges that there are undoubtedly flaws in the methodology, the results above indicate the present issue of published isolation for the health belief model. The health belief model is significantly isolated in its usage in articles that are categorized as "public environmental occupational health" compared with others, namely the second-closest category of "psychology." This is hypothesized to be a result of the constructs relating to health-specific behaviors and preventative health actions, rather than behaviors as a collective notion. It is understood that the HBM was developed as a specific model to explain health behaviors (Rosenstock, 1974a), however the question of the need for such specificity arises. If a model is applicable across the confines of disciplines, this can display the importance of knowledge sharing in using data to confront phenomena spanning the academic spectrum.

From the distributions quantified above, it is apparent that both game and systems theory have an increased dispersal in publication areas. Each has a nonsignificant differentiation between their publishing in engineering and computer science. It is noted that these disciplines have similarities but are still representative of differentiated schools of knowledge. In addition to just the top two categories of computer science and engineering, the multitude of varying disciplines present in the top ten areas showcases the interdisciplinary nature and usage of these two theories. Analyzing what elements have led to such a nature are the topic of interest below.

Analysis of Interdisciplinary Components of Theories:

Following a holistic review of the literature relating to game theory and systems theory, in comparison to the health belief model, distinct phenomena were noticed that alludes to their constructs' applicability and relevance across disciplines. Specific concepts have been identified, followed by two proposed categories that compile these concepts into collective ideas. The resulting categories of interest from the reviewed articles are comprehensive, generalized construct language and the line of interdisciplinary contextualization, described in the section below.

Figure 3: Interdisciplinary Theory Characteristics



Comprehensive, Generalized Language

Specific keywords and phrases were often incorporated into the text describing the theory constructs of systems theory and game theory, samples of which are noted in the table below.

Broad-Construct Language *(i.e. systems and game theory)*	Discipline-Specific Language (*i.e. health belief model)*
(Boulding, 1956) "Highly generalized constructions" "Framework of general theory" "Generalized ears" "General relationships of the empirical world"	(Janz & Becker, 1984) "preventative health behaviors" "health-related actions" "health education programming"
(Bot et al., 2007) "General principles" "Complete interconnectedness: all variables are interrelated"	(Rosenstock et al., 1988) "health-related actions" "patient" "perceived susceptibility to and severity of illness"
(Schilling, 2000) "coupling between components"	(Rosenstock, 1974a) "prevention of disease" "to avoid a disease" "disease would have at least moderate severity" "possibility of a disease occurrence"
(G. Chen & Kanfer, 2006) "contextual influences"	(Becker et al., 1977) "health behavior" "health-related actions" "health motivation"
(Kast & Rosenzweig, 1972) "unification of science"	(Harrison et al., 1992) "value-expectancy model to explain health actions" "individual health behaviors"
(Rabin, 1993) "broad range of economic models" "applied generally" "multiple applications"	(Becker, 1974) "medical model" "patient" "health and illness behavior"
(Brown et al., 1999) "theory we develop here should be general"	
(Hauert & Szabó, 2005) "interdisciplinary links" "link between unrelated disciplines"	

A significant occurrence in the description of the game or systems theory constructs were words such as ‘broad’ (G. Chen & Kanfer, 2006; Rabin, 1993; Saad et al., 2009) and ‘generalized’ (Boulding, 1956; Brown et al., 1999; Rabin, 1993; Schilling, 2000; Walby, 2007). It is proposed that these descriptors lay a foundation for researchers of various disciplines to take notice of its potential usage in describing phenomena of interest. This usage of taking a theory with broad descriptors and applying it to a specific situation was observed by Joshi et al. (1997) as a systems theory approach was utilized to describe the physics concept of Poiseuille flow. With this article being quantified as one of the top ten articles cited in the *Web of Science* relating to systems theory, it is apparent that the research team’s methods provided an example of interdisciplinary theory utilization to a broad audience. The same can be considered in Roth’s (1984) analysis of the labor market for medical interns by applying game theory concepts, or even Srivastava et. al’s (2005) study in using game theory to analyze wireless ad hoc networks.

As expected, an observation when analyzing the literature pertaining to the health belief model was the immense usage of the word ‘health’. In each article, the HBM was described as originating to provide an understanding of preventative health behaviors. As such, the descriptors of the model reference its applicability in health specifically and the use of these constructs has followed suit, alluding to its constructs’ lack of interdisciplinary characteristics. For reference, Becker (1974) terms the HBM as a ‘medical’ model of behavior, Austin et al. (2002) state its use to develop health interventions, and Janz & Becker (1984) consider the dimensions of the model to be used for health education programming. Harrison et al. (1992) performed a metaanalysis of the effectiveness of the HBM and required the study to pertain to health to be considered.

The constructs of perceived susceptibility and perceived severity were primarily presented in public health terms (Austin et al., 2002; Becker, 1974; Carpenter, 2010; Harrison et al., 1992; Janz & Becker, 1984; Maiman & Becker, 1974; Rosenstock, 1974b), rather than a general psychosocial approach, such as using terms like health behavior, perceived severity of disease, and illness. Often, subjects were listed as patients rather than described as individuals (Becker, 1974; Rosenstock et al., 1988), and topics of interest were relating to smoking, alcohol and substance abuse, physical activity, and dietary habits (Rosenstock et al., 1988), subconsciously limiting its scope to health-related situations.

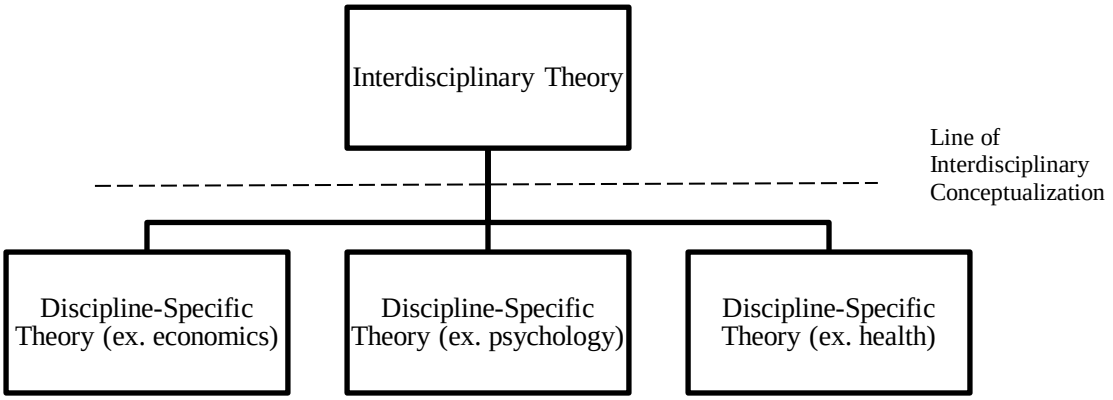
Line of Interdisciplinary Conceptualization

Most significantly, in explicitly stating their usage as a tool for widespread analysis in different fields (Hauert & Szabó, 2005; Srivastava et al., 2005; Wang et al., 2010), game and systems theory have subdivision capabilities in describing specific situations. Further, the overarching generalized theory is manipulated in describing a certain phenomenon, but it still represents the application of the overall model, such as the Nash equilibrium model being a defined subset of game theory or growth model being a subset of systems theory. This ability is termed by various phrases, such as multilevel (G. Chen & Kanfer, 2006), having subdivisions (Boulding, 1956), branches (Wang et al., 2010), even subsystems (Kast & Rosenzweig, 1972; Orr, 1998). To offer an example, Schilling (2000) notes how general systems theory can be applied to interfirm product modularity and derives a model that demonstrates how this general theory can be applied to a certain system. The importance of this characteristic, however, is the

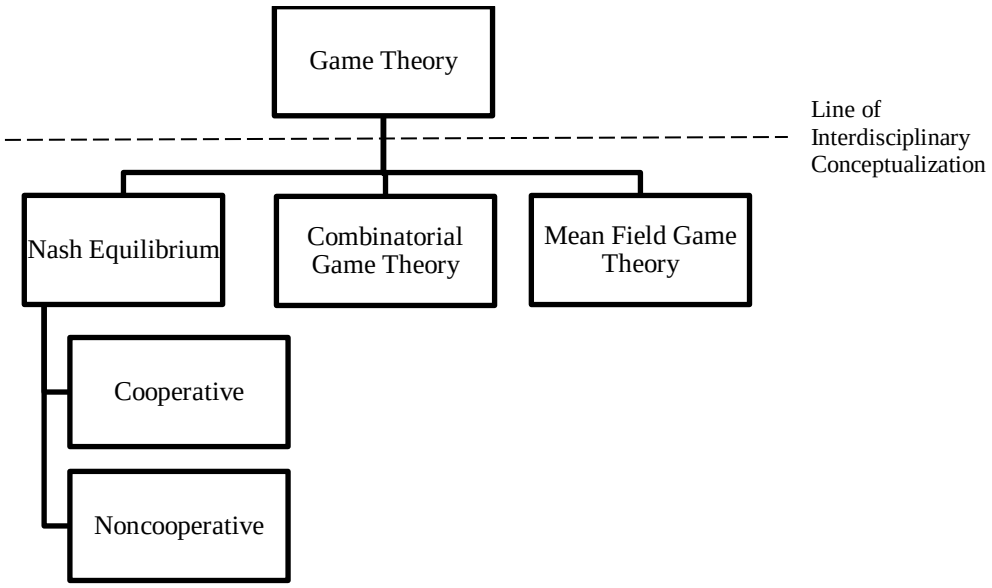
connection the specific theory makes in its utilization throughout different disciplines. It offers a unification of science (Kast & Rosenzweig, 1972) that is needed in promoting knowledge sharing throughout our academic world.

From this observation, the researcher proposes a term called "line of interdisciplinary conceptualization" for generating interdisciplinary theory. Theories that are above this line can be considered interdisciplinary and those that are below describe a specific phenomenon of interest. In theory development, researchers should ensure that there is no higher classification in describing the constructs through proper verbiage and descriptors. This concept is illustrated and then applied using game theory and a sample of its subdivisions.

Line of Interdisciplinary Conceptualization



Game Theory Representation



A common observation in this qualitative analysis was the promotion of system and game theory's ability to connect ideas into a holistic model. Brown et al. (1999), Hauert & Szabó (2005), Rabin (1993), Roth (2002), Saad et al. (2009), Srivastava et al. (2005) and Kast & Rosenzweig (1972) all allude to the importance of the interconnectedness of ideas that game theory and systems theory provide. The keywords used vary, as words such as connecting, interconnectedness, incorporation, cooperation and unifying were all present to distinguish the relationship between constructs and therefore, should be present above the line of interdisciplinary conceptualization. These concepts further the idea that an interdisciplinary theory is more than just broad and generalized, rather it emphasizes the potential for models to be explanatory of phenomena observed in different academic arenas.

In the literature, there was often criticism regarding the ability to measure the variables listed in the health belief model. Rosenstock (1974b) called into question the

lack of standardized questions to measure health perceptions. Carpenter (2010) discredited many studies relating to the HBM for having unreliable measures of the variables in question and a lack of understanding of outside influences within the model. The additional discussion of motivation and self-efficacy in the HBM resulted in a revised model being generated in 1975 (Harrison et al., 1992). Resultantly, this shows that the model was too narrowly defined, and under the line of interdisciplinary conceptualization, leading other researchers to have to make additional constructs to apply it to the phenomena in question. By initially developing a theory above this conceptual line, researchers can be more efficient in theory creation.

With the self-limiting constructs presenting the HBM as non-interdisciplinary, the most notable observation in the analysis of the health belief model was the call for increased generalizability and application. Becker (1974) called for future research in the model's applicability on a broader health scale and beyond. Carpenter (2010) concluded that the simple four-variable model should be abandoned in favor of a more complex, collective model. Maiman & Becker (1974) even call for a revised health belief model to relate to decision-making.

Guidelines for Interdisciplinary Theory Development:

Utilizing the characteristics discussed above, guidelines in theory development are proposed below. An interdisciplinary theory should contain language that is transferable to other fields but can include multiple discipline-specific examples if needed. For example, Becker (1974) described motivation in relation to the HBM model as, "differential emotional arousal in individuals caused by some given class of stimuli (e.g. health matters)." In the theories used in this thesis, referring to people as individuals

rather than patients can promote its use elsewhere. Finding strategies to broaden the language used when developing a theory can assist in having its insights applicable throughout academia.

The theory should also be able to exist in both an extensive, or rigidly structured, and strategic, or generalized, form, similar to game theory described by Myerson (1991). There should be a clear distinction present that can allow for the model to have interdisciplinary nature above the line, as well as specific derivatives under the line of interdisciplinary conceptualization. Although the HBM has connections with the social cognitive theory and theory of reasoned action, there exists no clear relationship between the models themselves (Carpenter, 2010). There have been six different parallel models of decision making similar to the HBM (Maiman & Becker, 1974), proving the notion that knowledge is consistently isolated to explaining specific situations rather than attempting to understand the interconnected world. Interdisciplinary models must maintain a complexity in describing situations, but also understand the potential interconnectedness of the phenomena. The following guidelines were generated by the researcher as a suggestion in developing interdisciplinary theory.

Guidelines for Interdisciplinary Theory Development:

1. Be cognizant to avoid field-specific verbiage when developing name and constructs, ensuring that they maintain generalizability and the appropriate broadness
2. Ensure that the theory can be placed above the line of interdisciplinary conceptualization through its ability to directly lead to subdivisions, or branched derivatives, to explain the desired phenomena of choice, warranting there would not effectively exist a more-generalized model

    If applicable:

    a. Offer specific theory branches that could describe certain discipline-specific environments
    b. Confirm that the theory can fit with varying descriptors if above the line

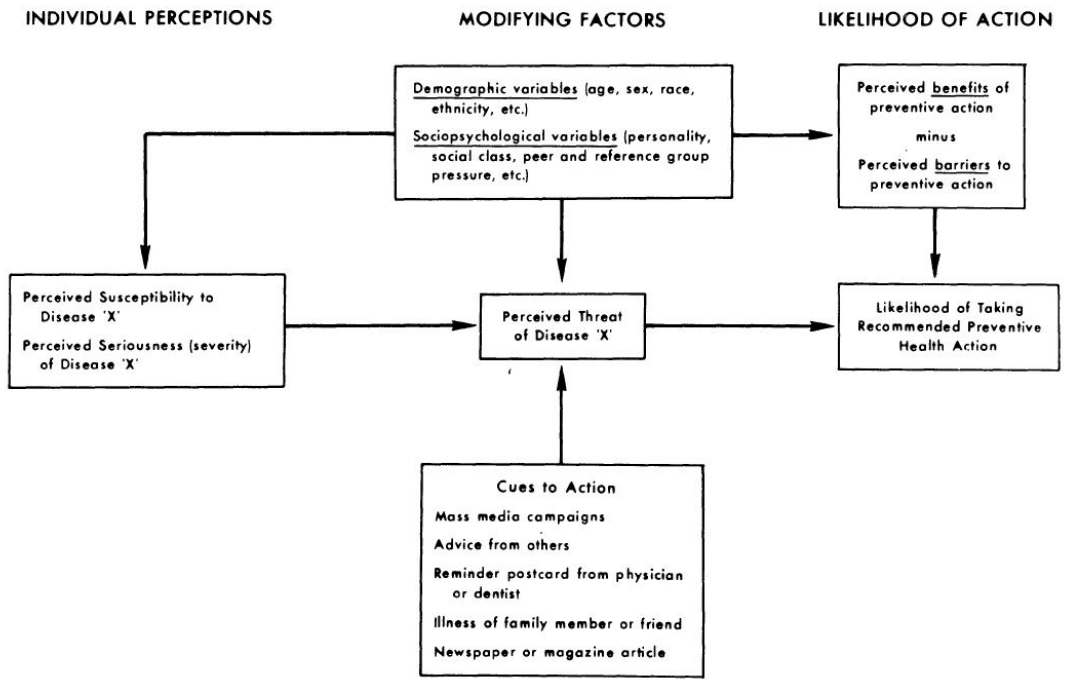
Discussion

In determining observed characteristics that an interdisciplinary theory contains, it is proposed that there could be distinct alternations to existing theories that transform their usage. Aligning with previous discussions, the health belief model will be a topic for such analysis.

The Health Belief Model – A New Context

In applying these interdisciplinary guidelines and characteristics, the health belief model is proposed to have an ability to be broadened in its usage to elevate it above the line of interdisciplinary contextualization. It is of note that the researcher believes that name ‘health belief model’ would additionally need changing, but for explanatory purposes, it will remain in this discussion. The following diagrams propose changes in the terminology relating to the HBM’s constructs to promote its applicability in areas outside of public health and above the interdisciplinary line. The comparison is made with the figure below describing some of the HBM constructs from Becker et al. (1977).

Figure 4: The Health Belief Model as described by Becker et al. (1977)



In exemplifying the second guideline in interdisciplinary theory development above, a redefined HBM will be proposed above the line of interdisciplinary contextualization, as well as derived theory below the line will be proposed. The HBM is proposed by the researcher as having potential applicability in the information science field due to links between volunteering and health. Soliciting volunteers in any non-profit organization can seem to evolve into a daunting task. Churches, as a non-profit organization, commonly find themselves in this predicament pleading for individuals to volunteer with a variety of duties, but often lacking the incentive or structure to effectively garner attention to their cause (Hager & Brudney, 2011). A multitude of theories have been investigated as they relate to volunteer intention (Wang et al., 2011), applying concepts such as Bandura's Social Cognitive Theory and Ajzen's Theory of Planned Behavior to illuminate the foundation of what entices volunteering in non-profit

organizations, but neither have effectively described such a phenomenon. With the transformed HBM and its noted effectiveness outside of health, this theory has the potential to be utilized to understand and solve this problem.

Research into the health benefits of volunteering has recently increased (Jenkinson et al., 2013). Casiday (2015) found volunteering to be associated with increased longevity, improved ability to carry out daily tasks, better health coping mechanism, adoption of healthy lifestyles, improved quality of life, social support, interaction, and self-esteem. It has also resulted in promoting physical and psychological health, such as increasing opportunities to learn health-related knowledge, facilitating a sense of importance of maintaining health, and cherishing more of what one has (L.-K. Chen, 2016). Volunteering is intrinsically rewarding because it leads to social recognition and a strong sense of identity (Sieber, 1974). Also, the act of helping others often makes people feel happier and healthier (Wuthnow, 1993).

It has been proposed that volunteer motivation is rooted in structuring leisure time, being socially integrated, gaining social approval, and boosting self-esteem (Okun, 1994). Additionally, volunteering is believed to generate substantial health benefits (Warner et al., 2014) in regard to both physical and mental health (Yunqing Li & Ferraro, 2006). Alfes, Shantz, & Bailey (2016) even found high levels of volunteer engagement are directly correlated with perceived happiness and social worth of volunteers. However, further understanding the motivations of volunteering is vital due to the forecasted shortage of volunteers in the future (Gottlieb & Gillespie, 2008) and the cessation of the health benefits once an individual's volunteering stops (Li, Chen, & Chen, 2013). Through a call for additional research on the HBM in new contexts to test for never-

before considered hypotheses (Lindsay & Strathman, 1997), previous associations of volunteering as a public health intervention (Jenkinson et al., 2013), as well as the need to establish a method to increase participation in volunteer efforts in church communities, the potential of future research testing the HBM in this context is needed. The following table was generated as an example of applying the revised HBM to non-profit volunteer behaviors.

Table 2: Application of the revised HBM on non-profit volunteer behaviors

HBM Construct	**Definition**	**Application in Volunteering**
Perceived Susceptibility	One's opinion of chances of getting a condition	How individuals feel about how the volunteer issue affects them personally or how susceptible they are to it (poverty, etc.)
Perceived Severity	One's opinion of how serious a condition and its consequences are	What is the perceived seriousness if they do not volunteer
Perceived Benefits	One's belief in the efficacy of the advised action to reduce risk or seriousness of impact	How individuals perceive the benefit of volunteering (i.e. moral boost, community service hours, social network)
Perceived Barriers	One's opinion of the tangible and psychological costs of the advised action	How individuals perceive the cons of volunteering (i.e. strain on lifestyle, age of volunteers, previous experiences, lack of knowledge)
Cues to Action	Strategies to activate "readiness"	Examples include video to promote volunteering, testimonials from other church volunteers, or any communication strategy created to influence volunteering
Self-Efficacy	Confidence in one's ability to act	Education on duties and responsibilities, how to sign up

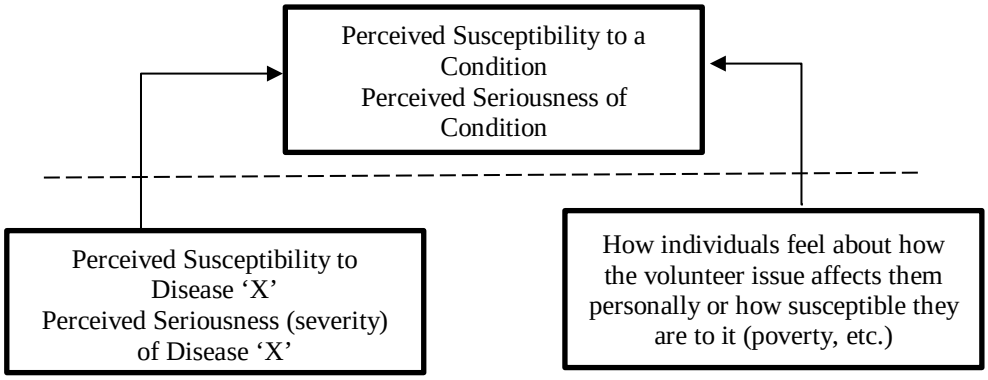
The researcher recognizes the omission of resulting data to defend this claim, but the goal is to exemplify the potential of sharing knowledge and models between fields. If

the HBM can be manipulated to provide a theory for describing church volunteer behaviors, imagine the results that could come when looking at even more theories, and when developing those of the future. The above table provides insight into the ability of the HBM to have more generalized constructs, while maintaining the ability to be derived into a specific application for a cause.

THE HEALTH BELIEF MODEL – REDEFINED

Below, the line of interdisciplinary conceptualization is displayed utilizing each construct of the health belief model in its current form alongside proposed interdisciplinary and volunteer-specific forms. These alterations follow the proposed guidelines in proposing the HBM's interdisciplinary nature and ability to have derivatives similar to game and systems theory.

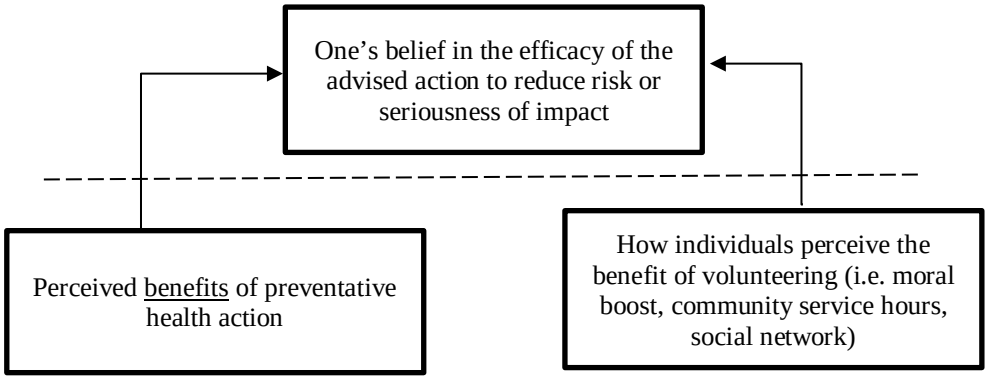
Figure 5: Health Belief Model Construct - Perceived Susceptibility/Seriousness



Altering the text from 'disease' to 'condition' in the generalized model offers researchers more flexibility into the phenomena of interest, as well as the ability to go below the line to mid-range theory. Condition may take on roles in the social sciences which contrast that of biological or environmental science. The

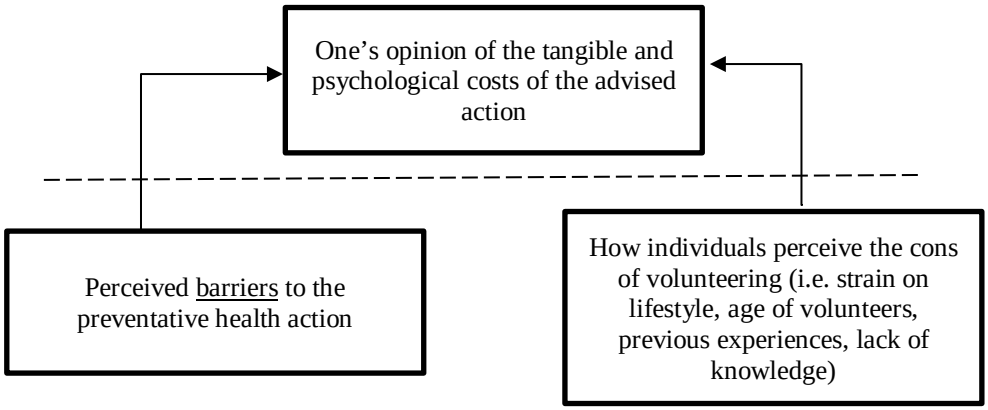
word ‘disease’ is proposed to limit the HBM in only referencing health-relating behaviors. In volunteering, perceived susceptibility would be centered on how the specific volunteer issue affects them personally. Using the proposed guidelines of developing an interdisciplinary theory, the construct was broadened and generalized, but also exhibited capabilities of describing specific situations, like disease or volunteering if necessary.

Figure 6: Health Belief Model Construct - Perceived Benefits



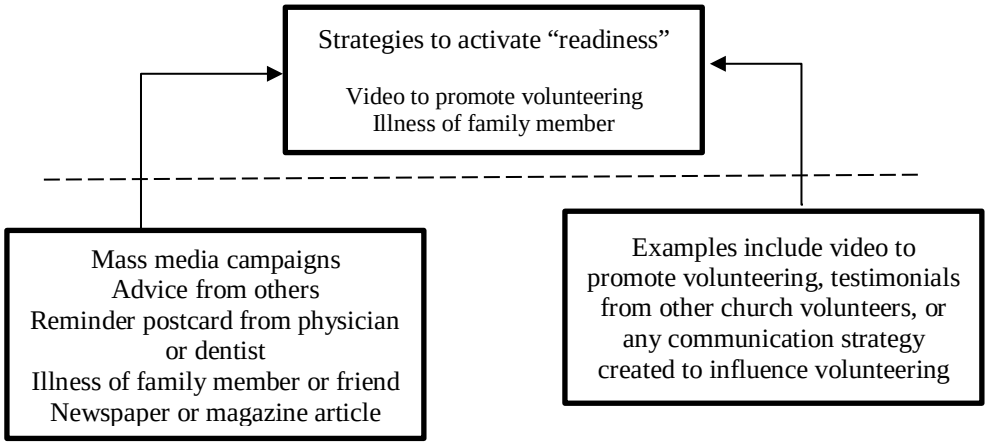
To broaden the language in accordance with the guidelines, the term ‘preventative health’ was eliminated to increase its interdisciplinarity. The process of performing an act to prevent disease can be related to ‘impact’, which is seen inserted. Further, ‘patient’ is commonly seen in article descriptors of the HBM, so explicitly using ‘one’s’ was included. With volunteering, the perceived benefits would be how the individual perceives the benefit of volunteering, whether that is a moral boast, community service hours, or even the increase in social network.

Figure 7: Health Belief Model Construct - Perceived Barriers



Similar to perceived benefits, eliminating 'preventive health' will produce a more interdisciplinary theory. Describing the construct using only 'action' is also meant to broaden the verbiage used. In volunteering, these perceived barriers can be the strain on one's lifestyle, lack of knowledge of the responsibilities, stigmas surrounding the age of volunteers, amongst other factors.

Figure 8: Health Belief Model Construct - Cues to Action



Cues to action has the most significant proposed transformation of all constructs. For the HBM to take on a uniquely interdisciplinary approach, the theory must be open for researchers to apply general concepts. By omitting defined examples, each unique discipline can apply the specific cues to action of certain behaviors. In accordance with the interdisciplinary theory guidelines, offering examples of multiple application of the generalized model is observed using health and volunteering.

CONCLUSION

From this study, the researcher has attempted to provide context to the ongoing trend of interdisciplinarity in academia and the need for theory to follow suit. Many models and theories, namely the health belief model in this discussion, are limited in their usage due to the description of the constructs from their original development and publishing. Such a limitation on the sharing of models can lead to isolation of knowledge, decreased collaboration, and most significantly, less efficiency in understanding the world around us.

Future research is needed for further analysis as to the specific components of interdisciplinary theory. It is meant that this thesis serves as a call-to-action for the scholarly community to recognize the systematic link between fields. The interconnectedness of phenomena can only be explained when researchers come together and share knowledge in an attempt to understand the natural world.

Although referenced in a multitude of research, interdisciplinary theory is not extensively defined as its own entity in great depth. The discussion of characteristics of the language and terminology used in a theory being categorized as interdisciplinary is minimal. The best processes in interdisciplinary theory development are largely lacking. Resultantly, there must be a new era of information management research that can contribute to answering some of these questions. With trends showcasing the increase in collaboration among research teams, the academic community must begin to examine the impact of interdisciplinarity theory in continuing this upward trend. It is not a simple call for new theories to be produced that explain phenomena from a grandiose scale, rather an analysis of previous theories and their lack of interdisciplinary characteristics can lay a

foundation for future work and development. Through an interdisciplinary approach in understanding the interplay of distinct phenomena, scholars can begin to demonstrate the power and impact of knowledge sharing in solving some of society's greatest challenges.

REFERENCES

Alfes, K., Shantz, A., & Bailey, C. (2016). Enhancing volunteer engagement to achieve desirable outcomes: What can non-profit employers do? *Voluntas: International Journal of Voluntary & Nonprofit Organizations*, *27*(2), 595–617. https://doi.org/10.1007/s11266-015-9601-3

Allen, T. J. (1977). *Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization*. Cambridge, Mass: MIT Press.

Amabile, T. M. (1988). A model of creativity and innovation in organizations. *Research in Organizational Behavior*, (10), 123–167.

Austin, L. T., Ahmad, F., McNally, M.-J., & Stewart, D. E. (2002). Breast and cervical cancer screening in Hispanic women: A literature review using the health belief model. *Women's Health Issues*, *12*(3), 122–128.

Balbach, E. D., Smith, E. A., & Malone, R. E. (2006). How the health belief model helps the tobacco industry: Individuals, choice, and "information." *Tobacco Control*, *15*, iv37–iv43. https://doi.org/10.1136/tc.2005.012997

Becker, M. H. (1974). The health belief model and sick role behavior. *Health Education Monographs*, *2*(4), 409–419.

Becker, M. H., Maiman, L. A., Kirscht, J. P., Haefner, D. P., & Drachman, R. H. (1977). The health belief model and prediction of dietary compliance: A field experiment. *Journal of Health and Social Behavior*, *18*(4), 348–366. https://doi.org/10.2307/2955344

Bertalanffy, L. V. (1969). *General system theory: Foundations, development, applications* (Revised edition). New York: George Braziller Inc.

Bot, K. D., Lowie, W., & Verspoor, M. (2007). A dynamic systems theory approach to second language acquisition. *Bilingualism: Language and Cognition*, *10*(1), 7–21. https://doi.org/10.1017/S1366728906002732

Boulding, K. E. (1956). General systems theory - The skeleton of science. *Management Science*, *2*(3), 197–208.

Brown, J. S., Laundré, J. W., & Gurung, M. (1999). The ecology of fear: Optimal foraging, game theory, and trophic interactions. *Journal of Mammalogy*, *80*(2), 385–399.

Carpenter, C. J. (2010). A meta-analysis of the effectiveness of health belief model variables in predicting behavior. *Health Communication*, *25*(8), 661–669. https://doi.org/10.1080/10410236.2010.521906

Casiday, D. R. (2015). Volunteering and health: What impact does it really have? *ResearchGate*. Retrieved from: https://www.researchgate.net/publication/228628782_Volunteering_and_Health_What_Impact_Does_It_Really_Have

Chen, G., & Kanfer, R. (2006). Toward a systems theory of motivated behavior in work teams. *Research in Organizational Behavior*, *27*, 223–267. https://doi.org/10.1016/S0191-3085(06)27006-0

Chen, L.-K. (2016). Benefits and dynamics of learning gained through volunteering: A qualitative exploration guided by seniors' self-defined successful aging. *Educational Gerontology*, *42*(3), 220–230. https://doi.org/10.1080/03601277.2015.1108150

Cochrane, A. J., Dick, B., King, N. A., Hills, A. P., & Kavanagh, D. J. (2017). Developing dimensions for a multicomponent multidisciplinary approach to obesity management: A qualitative study. *BMC Public Health, 17,* 1–15. https://doi.org/10.1186/s12889-017-4834-2

Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons and evaluative criteria. *Zeitschrift Für Soziologie, 19*(6), 418–427. https://doi.org/10.1515/zfsoz-1990-0602

Cummings, J. N., & Kiesler, S. (2005). Collaborative research across disciplinary and organizational boundaries. *Social Studies of Science*, *35*(5), 703–722.

Elster, J. (1982). The case for methodological individualism. *Theory and Society*, *11*(4), 453–482.

Engerer, V. (2017). Exploring interdisciplinary relationships between linguistics and information retrieval from the 1960s to today. *Journal of the Association for Information Science and Technology*, *68*(3), 660–680. https://doi.org/10.1002/asi.23684

Feilzer, M. Y., M. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research*, *4*(1), 6–16. https://doi.org/10.1177/1558689809349691

Ferrero, R. W., Shahidehpour, S. M., & Ramesh, V. C. (1997). Transaction analysis in deregulated power systems using game theory. *IEEE Transactions on Power Systems*, *12*(3), 1340–1347. https://doi.org/10.1109/59.630479

Fishbein, M., & Middlestadt, S. (1995). Noncognitive effects on attitude formation and change: Fact or artifact? *Journal of Consumer Psychology, 4*(2), 181–202. https://doi.org/10.1207/s15327663jcp0402_05

Geschwind, L., & Melin, G. (2016). Stronger disciplinary identities in multidisciplinary research schools. *Studies in Continuing Education, 38*(1), 16–28. https://doi.org/10.1080/0158037X.2014.1000848

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Hawthorne, N.Y: Aldine de Gruyter.

Glazier, J. D., & Grover, R. (2002). A multidisciplinary framework for theory building. *Library Trends, 50*(3), 317.

Gottlieb, B. H., & Gillespie, A. A. (2008). Volunteerism, health, and civic engagement among older adults. *Canadian Journal on Aging / La Revue Canadienne Du Vieillissement, 27*(4), 399–406. https://doi.org/10.3138/cja.27.4.399

Greene, J. A., & Loscalzo, J. (2017, December 20). Putting the patient back together — Social medicine, network medicine, and the limits of reductionism [editorial]. https://doi.org/10.1056/NEJMms1706744

Hager, M. A., & Brudney, J. L. (2011). Problems recruiting volunteers: Nature versus nurture. *Nonprofit Management and Leadership, 22*(2), 137–157. https://doi.org/10.1002/nml.20046

Harrison, J., Mullen, P., & Green, L. (1992). A metaanalysis of studies of the health belief model with adults. *Health Education Research, 7*(1), 107–116. https://doi.org/10.1093/her/7.1.107

Hauert, C., & Szabó, G. (2005). Game theory and physics. *American Journal of Physics*, *73*(5), 405–414. https://doi.org/10.1119/1.1848514

Hendry, J., & Seidl, D. (2003). The structure and significance of strategic episodes: Social systems theory and the routine practices of strategic change. *Journal of Management Studies*, *40*(1), 175–196. https://doi.org/10.1111/1467-6486.00008

Hesse, B. W., Sproull, L. S., Kiesler, S. B., & Walsh, J. P. (1993). Returns to science: Computer networks in oceanography. *Communications of the ACM*, *36*(8), 90–101.

Jacso, P. (2005). As we may search - Comparison of major features of the web of science, scopus, and google scholar citation-based and citation-enhanced databases. *Current Science*, *89*(9), 1537–1547.

Janz, N. K., & Becker, M. H. (1984). The health belief model: a decade later. *Health Education & Behavior*, *11*(1), 1–47. https://doi.org/10.1177/109019818401100101

Jenkinson, C. E., Dickens, A. P., Jones, K., Thompson-Coon, J., Taylor, R. S., Rogers, M., Richards, S. H. (2013). Is volunteering a public health intervention? A systematic review and meta-analysis of the health and survival of volunteers. *BMC Public Health*, *13*(1), 1–10. https://doi.org/10.1186/1471-2458-13-773

Ji-Wei Wang, Chang-Nian Wei, Harada, K., Minamoto, K., Ueda, K., Hong-Wei Cui, Ueda, A. (2011). Applying the social cognitive perspective to volunteer intention in China: The mediating roles of self-efficacy and motivation. *Health Promotion International*, *26*(2), 177–187. https://doi.org/10.1093/heapro/daq056

Joshi, S. S., Speyer, J. L., & Kim, J. (1997). A systems theory approach to the feedback stabilization of infinitesimal and finite-amplitude disturbances in plane Poiseuille flow. *Journal of Fluid Mechanics*, *332*, 157–184. https://doi.org/10.1017/S0022112096003746

Kast, F. E., & Rosenzweig, J. E. (1972). General systems theory: Applications for organization and management. *The Academy of Management Journal*, *15*(4), 447–465. https://doi.org/10.2307/255141

Kirn, J. M. (1991). Religion and the health belief model. *Journal of Religion and Health, 30*(4), 321–329.

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities*. Charlottesville, Va: University Press of Virginia.

Koch, J., Zhu, Z., Cannon, J., Armstrong, M., & Owen, D. (2005). College students, tattooing, and the health belief model: Extending social psychological perspectives on youth culture and deviance. *Sociological Spectrum*, *25*(1), 79–102. https://doi.org/10.1080/027321790500121

Leridon, H. (2015). The development of fertility theories: A multidisciplinary endeavor. *Teorias De La Fecundidad: ¿Demografos Bajo Influencia?*, *70*(2), 309–348. https://doi.org/10.3917/pope.1502.0309

Li, Y.-P., Chen, Y.-M., & Chen, C.-H. (2013). Volunteer transitions and physical and psychological health among older adults in Taiwan. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *68*(6), 997–1008. https://doi.org/10.1093/geronb/gbt098

Lindsay, J. J., & Strathman, A. (1997). Predictors of recycling behavior: An application of a modified health belief model. *Journal of Applied Social Psychology, 27*(20), 1799–1823.

Maiman, L. A., & Becker, M. H. (1974). The health belief model: Origins and correlates in psychological theory. *Health Education & Behavior, 2*(4), 336–353. https://doi.org/10.1177/109019817400200404

Malecic, A. (2017). Footprints of general systems theory. *Systems Research and Behavioral Science*, *34*(5), 631–636. https://doi.org/10.1002/sres.2484

Mele, C., Pels, J., & Polese, F. (2010). A brief review of systems theories and their managerial applications. *Service Science, 2*(1–2), 126–135. https://doi.org/10.1287/serv.2.1_2.126

Miranda, F. (2014). *Systems theory: Perspectives, applications and developments.* Hauppauge, New York: Nova Science Publishers, Inc. Retrieved from https://login.pallas2.tcl.sc.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=776164&site=ehost-live

Myerson, R. B. (1991). *Game theory: Analysis of conflict.* Cambridge, Mass: Harvard University Press.

Okun, M. A. (1994). The relation between motives for organizational volunteering and frequency of volunteering by elders. *Journal of Applied Gerontology, 13*(2), 115–126. https://doi.org/10.1177/073346489401300201

Olds, D. D. (2006). Interdisciplinary studies and our practice. *Journal of the American Psychoanalytic Association*, *54*(3), 857–876. https://doi.org/10.1177/000\306510 60540031101

Orr, K. (1998). Data quality and systems theory. *Communications of the ACM*, *41*, 66–71. https://doi.org/10.1145/269012.269023

Osborne, M. J., & Rubinstein, A. (1994). *A course in game theory*. Cambridge, Mass: MIT Press.

Pool, R. (1995). Putting game theory to the test. *Science*, *267*(5204), 1591–1593.

Rabin, M. (1993). Incorporating fairness into game theory and economics. *American Economic Review*, *83*(5), 1281.

Rapoport, A. (1992). Game theory defined. *Rationality & Society*, *4*(1), 74–82.

Rawlings, C. M., McFarland, D. A., Dahlander, L., & Wang, D. (2015). Streams of thought: Knowledge flows and intellectual cohesion in a multidisciplinary era. *Social Forces*, *93*(4), 1687–1722.

Reeves, S., Albert, M., Kuper, A., & Hodges, B. D. (2008). Qualitative research: Why use theories in qualitative research? *BMJ: British Medical Journal*, *337*(7670), 631–634.

Rogers, Y., Rizzo, A., & Scaife, M. (2003). *Interdisciplinarity: An emergent or engineered process?* Brighton: University of Sussex, School of Cognitive and Computing Sciences.

Rorty, R. (1963). Empiricism, extensionalism, and reductionism. Mind, 72(286), 176–186.

Rosenstock, I. M. (1974a). Historical origins of the health belief model. *Health Education & Behavior*, *2*(4), 328–335. https://doi.org/10.1177/109019817400200403

Rosenstock, I. M. (1974b). The health belief model and preventive health behavior. *Health Education & Behavior*, *2*(4), 354–386. https://doi.org/10.1177/109019817400200405

Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the health belief model. *Health Education & Behavior*, *15*(2), 175–183. https://doi.org/10.1177/109019818801500203

Ross, F. (2009). Degrees of disciplinarity in comparative politics: Interdisciplinarity, multidisciplinarity and borrowing. *European Political Science*, *8*(1), 26–36. https://doi.org/10.1057/eps.2008.14

Roth, A. E. (1984). The evolution of the labor market for medical interns and residents: A case study in game theory. *Journal of Political Economy*, *92*(6), 991–1016. https://doi.org/10.1086/261272

Roth, A. E. (2002). The economist as engineer: Game theory, experimentation, and computation as tools for design economics. *Econometrica*, *70*(4), 1341–1378. https://doi.org/10.1111/1468-0262.00335

Saad, W., Han, Z., Debbah, M., Hjorungnes, A., & Basar, T. (2009). Coalitional game theory for communication networks. *IEEE Signal Processing Magazine*, *26*(5), 77–97. https://doi.org/10.1109/MSP.2009.000000

Salari, R., & Filus, A. (2016). Using the health belief model to explain mothers' and fathers' intention to participate in universal parenting programs. *Prevention Science: The Official Journal of the Society for Prevention Research*. https://doi.org/10.1007/s11121-016-0696-6

Schilling, M. A. (2000). Toward a general modular systems theory and its application to interfirm product modularity. *The Academy of Management Review, 25*(2), 312–334. https://doi.org/10.2307/259016

Sieber, S. D. (1974). Toward a theory of role accumulation. *American Sociological Review, 39*(4), 567–578. https://doi.org/10.2307/2094422

Silva, F. N., Rodrigues, F. A., Oliveira, O. N., & da F. Costa, L. (2013). Quantifying the interdisciplinarity of scientific journals and fields. *Journal of Informetrics, 7*(2), 469–477. https://doi.org/10.1016/j.joi.2013.01.007

Srivastava, V., Neel, J., Mackenzie, A. B., Menon, R., Dasilva, L. A., Hicks, J. E., Gilles, R. P. (2005). Using game theory to analyze wireless ad hoc networks. *IEEE Communications Surveys Tutorials, 7*(4), 46–56. https://doi.org/10.1109/COMST.2005.1593279

Taylor, D., Bury, M., Campling, N., Carter, S., Garfield, S., Newbould, J., & Rennie, T. (2006). A review of the use of the health belief model (HBM), the theory of reasoned action (TRA), the theory of planned behaviour (TPB) and the trans-theoretical model (TTM) to study and predict health related behaviour change. *London, UK: National Institute for Health and Clinical Excellence*, 1–215.

Walby, S. (2007). Complexity theory, systems theory, and multiple intersecting social inequalities. *Philosophy of the Social Sciences, 37*(4), 449–470. https://doi.org/10.1177/0048393107307663

Wang, B., Wu, Y., & Liu, K. J. R. (2010). Game theory for cognitive radio networks: An overview. *Computer Networks, 54*(14), 2537–2561. https://doi.org/10.1016/j.comnet.2010.04.004

Warner, L. M., Wolff, J. K., Ziegelmann, J. P., & Wurm, S. (2014). A randomized controlled trial to promote volunteering in older adults. *Psychology and Aging*, *29*(4), 757–763. https://doi.org/10.1037/a0036486

Wuthnow, R. (1993). *Acts of compassion: Caring for others and helping ourselves* (Vol. 98). Princeton University Press.

Xiao, A., Zeng, S., Allen, J. K., Rosen, D. W., & Mistree, F. (2005). Collaborative multidisciplinary decision making using game theory and design capability indices. *Research in Engineering Design*, *16*(1–2), 57–72. https://doi.org/10.1007/s00163-005-0007-x

Yoon, H. J., & Kim, Y. J. (2016). Understanding green advertising attitude and behavioral intention: An application of the health belief model. *Journal of Promotion Management*, *22*(1), 49–70. https://doi.org/10.1080/10496491.2015.1107006

Young, I. M. (1997). Unruly categories: A critique of Nancy Fraser's dual systems theory. *New Left Review*, (222), 147–160.

Yunqing Li, & Ferraro, K. F. (2006). Volunteering in middle and later life: Is health a benefit, barrier or both? *Social Forces*, *85*(1), 497–519.